Review Article

Oils and Fats Consumed in Indian Diet: Effect on Anthropometric Parameters, Lipid Profiles and Risk of Developing Chronic Diseases

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Abstract

Objective

The objective of this study was to review the most commonly used edible oils and fats in India, determine their effect on lipid profile and anthropometric parameters and study their association with the development of non-communicable diseases such as cardiovascular diseases and diabetes.

Methods

A comprehensive literature search was conducted using a combination of search terms by two independent researchers using PubMed and Google Scholar from 2010 to January 2019. Studies including adult population evaluating the effect of different vegetable oils and fats via both observational and experimental designs were included. Reviews of studies in similar area were also included. The searches were managed in Mendeley, and duplicate entries were removed. Titles and abstracts of retrieved articles were screened by two reviewers. A tailored data abstraction tool was used to record characteristics of included studies, such as location, outcomes assessed, findings and demographics, by the study authors. Furthermore, data on the parameters compared and outcomes measured were recorded for quantitative studies.

Results

In total, 34 articles were reviewed. Vanaspati and ghee were the most commonly used oils and fats in the Northern states of India, whereas groundnut oil was preferred in the Southern and Western states. All forms of coconut oil, including virgin- and extra-virgin forms, showed an overall beneficial effect on anthropometric parameters, with decreases in BMI, waist circumference and neck circumference and an increase in lean muscle mass. Coconut oil has been linked to improved lipid profile, and sunflower oil and ghee also showed similar effects. Intake of >1.25 kg/month of ghee along with <0.5 L/month of mustard oil have been reported to cause a decrease in total cholesterol levels. Overall, 15 studies reported that coconut oil has a protective effect on cardiovascular health. Owing to its anti-inflammatory effects, olive oil has been associated with a decreased risk for diabetes.

Conclusions

With the emerging middle class and shifting demand towards packaged-food options, it is important that the impact of edible oils on health are understood well. Edible oils are only one important aspect of diet. As public health nutrition professionals, it is also important to emphasise on choosing an overall healthier diet.

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Keywords

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Introduction

India is witnessing a slow decline in the number of undernourished individuals and an ensuing surge in the incidence of non-communicable diseases (NCDs), such as cardiovascular diseases (CVD), diabetes and cancers. Not only are increasing numbers of Indians dying from CVD but also they are experiencing events, such as myocardial infarction, on average, 10 years earlier than other ethnicities and are predisposed to developing important risk factors, such as hypertension and diabetes mellitus, even in the absence of obesity.[1] Furthermore, there are large state-wide variations in risk factor prevalence and disease patterns. Unhealthy diet and sedentary lifestyle are common factors fueling this double whammy of malnutrition.[2] Dietary factors, in particular the consumption of edible oils and fats, have been linked to the prevention, causation and management of NCDs.[3,4]

With an average per capita oil consumption of 14.3 kg/year, India ranks as the fifth largest edible oil market after USA, China, Brazil and Argentina. The branded packaged edible oil sector in retail accounts for 40% of the total edible oil consumption. India is a producer of nine oilseed crops: soybean, mustard, sunflower, safflower, groundnut, sesame and niger are the edible varieties and castor and linseed are the non-edible varieties. Additionally, rice bran, cottonseed and corn germ are also used to extract edible oil.[5] In 2017, the country's vegetable oil consumption was at 23 million tonnes. However, domestic oilseed production growth could not keep up with the rising demand, and consequently, approximately 15.5 million tonnes of edible oils (i.e., palm, soybean and sunflower oils) were imported. The principal constituents of edible oils and fats are glycerin esters and fatty acids, which are further differentiated by their triglyceride structure and proportion of saturated fatty acids (SFA) and unsaturated fatty acids. The effect of oils and fats depends not only on their nutritional composition but also on the method of cooking.[6] The fatty acids are converted from cis-configuration to trans-configuration during partial hydrogenation, which adversely affects the lipid profile and increases the risk of developing atherosclerosis and, thus, CVD.[7]

Oils and fats are concentrated forms of energy, and the energy yield from the complete oxidation of fatty acids is approximately 9 kcal/g, compared to approximately 4 kcal/g from carbohydrates and proteins. Triglycerides, molecules with a backbone of glycerol to which fatty acids (chain-like molecules of carbon, hydrogen and oxygen) are linked in groups of three, are the most abundantly found fats in foods. When foods containing fats are consumed, the fatty acids are separated from their glycerol backbone during the process of digestion. Oils and fats in the diet are thus available to the body as fatty acids. The categorizations of fatty acids have been presented in Box 1. The main sources of fat in a typical Indian diet, which is predominantly either rice- or wheat-based, are vegetable oils, ghee (clarified butter), milk and dairy products. The revised recommended dietary allowances (RDA) for Indians released in 2010 recommend reduced intake of ghee and traditional oils, such as coconut and groundnut oils, and increased usage of new PUFA-rich oils, such as safflower and sunflower oils. This is in accordance to the general hype against the usage of SFA in diet, as in the dietary recommendations of 1980s and 1990s. The National Nutrition Monitoring Bureau (NNMB) data showed that during 1980–2002, there was an increase in the dietary intake of fat, both in urban and rural India. However, notably, the overall fat intake continued to be <15% of the total energy intake in many states of India. Pingali and Khwaja have demonstrated that although the total caloric intake per capita has increased over the past three decades, the contribution of animal food sources (that contain SFA) continues to be minimal.[8] Surveys by the Indian Agricultural Research Institute have suggested that the trends in the consumption of different edible oils have changed over the past three decades.[9] There has been an overall increase in the consumption of refined oils, with a decrease in the intake of ghee/vanaspati. The concern over the significantly higher consumption of oils (such as vegetable oils with unsaturated fatty acids, e.g., sunflower and soybean oils) is equal in both urban and rural areas.[10] Two serious considerations need to be made; first, there are many people in India whose diets do not include sufficient fats, and second, the composition of a typical Indian diet, unfortunately, has all the components that lead to a deleterious plasma lipid profile—high carbohydrate, low fat in the diets of the poor, low SFA, high LA and low omega-3 PUFA.

There are many myths, confusions and controversies in public health surrounding the usage of oils and fats.[11] Considering the significance of edible oils and fats in the Indian diet and their impact on nutrition, health and NCDs, the present study was performed to review the most commonly used edible oils and fats in India, determine their effect on lipid profile and anthropometric parameters and study their association with the development of NCDs such as CVD and diabetes.

Materials and Methods

Search strategy

A comprehensive literature search was conducted by two independent researchers using PubMed and Google Scholar from 2010 to January 2019. In addition, grey literature including reports and related publications from organizations like National Institute of Nutrition (NIN), National Sample Survey Organization (NSSO), Indian Vanaspati Producers' Association, United Nations (UN), World Health Organization (WHO) and NGOs and articles from Google Scholar were reviewed.

We employed a combination of search terms using keywords, such as names of specific oils (mustard, coconut, groundnut, etc.), oils and fats, edible oils and fats, chronic diseases, anthropometric parameters, weight, body mass index (BMI), waist circumference, overweight, obesity, lipid profile, cholesterol, CVD risk, myocardial infarction, atherosclerosis, diabetes risk and blood glucose.

Selection criteria

Relevant studies were identified on the basis of the following predetermined inclusion criteria:

i. Study population: Adults (aged ³ 18 years) and infants (aged £ 1 year) including both males and females. Studies with Indian population were preferred in the specified age group; however, in areas with a lack of studies in the field, particularly for a specific oil/fat, studies with non-Indian population and those on animals were included.[12]

ii. Outcome: Studies/reports were included if they described the composition of edible oils and fats and their effect on health outcomes related to the four following biological factors in an Indian population:

a. Anthropometric parameters (weight, BMI, waist circumference and skinfolds)

b. Lipid profile

c. CVD risk

d. Risk for developing diabetes

iii. Type of study/reports: Studies with both observational and experimental designs as well as reviews and reports were included.

iv. Availability of full text.

v. Published in English language.

Exclusion criteria

I. Study Population: Study population including children and adolescents.

ii. Outcome: Studies evaluating the effect on other health outcomes not related to the four aforementioned biological factors.

Study selection and data extraction

The searches were managed in Mendeley, duplicate entries were removed and titles and abstracts of retrieved articles were screened by two reviewers. Articles were included or excluded as per the criteria, and full texts of all retained articles were screened. Next, the lists were compiled and matched for any discrepancies. Disagreements between the reviewers were resolved by discussion with senior investigator.

Data abstraction and quality assessment

The reviewers extracted data from the included studies in MS Excel. A tailored data abstraction tool, which was created as a template on MS Excel, was used by the study authors to record the characteristics of the included studies, such as location, outcomes assessed, findings and demographics. For quantitative studies, we further recorded data on the parameters compared and outcomes measured. For qualitative studies, we noted additional information on the study perspective and the main themes identified. Type of intervention, mode of delivery and descriptions were also recorded in case of interventional studies.

Results

Types of oils and fats consumed in India

The types of oils and fats used in India are diverse, and the variability is directly affected by preference, cost and availability in that particular region.[13] Dorni et al collected at total of 320 samples of edible oils and fats across India. The highest number of samples collected was of mustard oil followed by soybean and sunflower oils. Very few samples were obtained for corn (n = 1) and cottonseed oils (n = 2). On the other hand, samples for sunflower oil (n = 39), mustard oil (n = 59), soybean oil (n = 46), gingelly oil (n = 24), ghee (n = 39) and vanaspati (n = 45) were obtained in higher numbers from all parts of India. The highest number of samples of vanaspati and ghee were obtained from the northern region of India.[13] The preference for groundnut oil in Southern and Western states has also been highlighted by Srinivasan et al.[14] The use of hydrogenated vegetable oils (HVO) was noted to be prevalent in the Northern states, particularly Punjab, Haryana, Uttar Pradesh and Himachal Pradesh. Although oils such as soybean, rice bran and cottonseed are generally not preferred due to their taste, they are used in the manufacturing of HVO.[15]

Composition and regional consumption patterns of some commonly used edible oils and fats in India

The Indian Council of Medical Research (ICMR) has recommended increased consumption of omega-3 PUFA in the Indian diet considering the skewed omega-6/omega3 ratio that has been noted in a typical Indian diet. Mustard, soybean and canola oils contain alpha-linolenic acid, an omega-3 fatty acid, in high quantities. While mustard and soybean oils are not preferred in the Southern and Western states owing to their flavour, the use of canola oil, despite being a good option, is limited owing to its high cost and low availability.[16] The compositions of the oils and fats commonly used in India have been listed in Table 1 and the key points from the same are summarized below.

Table 1: Fatty acid profile of edible oils commonly consumed in India

Type of oil	SFA (%)	MUFA (%)	PUFA (%)	OMEGA-6 (%)	OMEGA-3 (%)
Soybean	10–19	17–44	4–70	48–59	4–11
Sunflower	8–17	14–40	2–74	48–74	0–0.3
Groundnut	12–28	36–72	12–43	12–43	0–0.3
Mustard	1–12	35–89	16–44	10–24	6–18
Safflower	7–13	8–24	6–83	68–83	0–0.1
Coconut	81–107	5–10	1–3	1–2	0–0.2
Olive	8–17	55–85	3–22	3–21	0–2
Sesame	13–17	34–46	37–49	37–48	0–1
Rice Bran	15–28	38–47	33–43	33–40	0–3
Palm	43–57	36–45	9–12	9–12	0–0.5
Palm kerlen	82	15	2		
Ghee	56–65	21–32	11	7	10
Vanaspati	24	19			
Red Palm (Raw)	50	40	9		
Cotton Seeds	21–28	20–25	52		
Corn	12–17	32–34	50		

MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids *Ranges adapted from Ghafoorunissa, 1994*[56]*; Johnson et al, 2009*[57]*; Dorni et al, 2018*[13]*; Manchanda et al 2016*[58]

India is the third largest producer of coconut. *Coconut oil* is extracted from dried coconut kernel. This type of oil is mostly preferred in the Southern states of India, particularly Kerala. SFA make up 90.84% of coconut oil, out of which 49.57% and 21.12% are lauric and myristic acids, respectively.[13] Its high content of SFA makes it resistant to oxidative reactions and also suitable for use in baking and frying.[17]

The study by Dixit et al revealed that the amount of SFA, MUFA and PUFA in *soybean, sunflower and mustard oils* are within the range recommended by Codex Standard (2005).[15] As much as 70% of the mustard oil produced is utilized by the northern and eastern parts of the India. The predominant fatty acid in mustard oil is erucic acid (48.5%–54.02%).[13,15] The European Union, New Zealand and Australia, however, have set the maximum limit for erucic acid as 5% of total fatty acids because it has been associated with myocardial lipidosis. Linoleic acid is most abundantly found in soybean and sunflower oils and next in mustard oil.[13,15] Oleic acid has been reported to be found in the range of 16.0%–28.2%, 27.3%–32.6% and 10.3%–18.7% in sunflower, soybean and mustard oils, respectively.[15] The trans fatty acids (TFA) levels in soybean, sunflower and mustard oils are well below the limit of <10% prescribed by FSSAI; however, these are above the limits followed in Denmark (of <2%).[15]

India is the second largest producer of *groundnut* after China. Ten percent of the world's total vegetable oil production is accounted by India's groundnut oil production. Groundnut oil has a high smoke point, thereby making it suitable for deep frying of foods. This oil is mostly preferred in the southern and western parts of India.[18] Groundnut oil is rich in MUFA, which is primarily formed by oleic acid.[13]

The fatty acid present in the highest concentration in *corn oil* is linoleic acid (48.9%), followed by oleic and palmitic acids. The remaining oils include palmitoleic, archidic, linolenic, lignoceric and behenic acids. Likewise, *cottonseed oil* also majorly comprises linoleic and palmitic acids. It has a high omega-6/omega-3 ratio, and the PUFA/SFA ratio is 1.85. Refined cottonseed oil is considered safe for human consumption.[19]

Gingelly oil is rich in PUFA and low in total saturated fatty acid (TSFA), yet it has good stability against oxidative rancidity. This property has been credited to the presence of strong antioxidants such as sesamin, sesamol, and sesamolin dimer.[20] Linoleic and oleic acids are present in the highest proportions in gingelly oil.[13]

The import of *palmolein oil* from South-east Asia has seen a gradual rise, and 90% of it is used for edible purposes.[21] The levels of oleic (42.57%–45.15%) and palmitic acids (37.10%–40.57%) are high in this oil, with the latter being a SFA, and the consumption of palmitic acid has been linked to the likelihood of increased low density lipoprotein (LDL) levels, which is further linked to coronary heart disease.[22]

After China, India ranks second in the production of *rice bran oil*, giving an output of 160 metric tonnes of rice bran oil per year (2014–15). Rice bran oil has a more balanced MUFA/PUFA ratio of 1:1, with oleic acid as the predominant fatty acid. It suitable for frying, owing to its stability, and also imparts a preferable flavour to the food. It also contains bioactive compounds, such as oryzanol, tocotrienols, phytosterol and squalene.[13]

Safflower is produced in large quantities in India, Australia, Mexico, the USA and Ethopia.[23] Safflower oil is thermally stable and has a high smoke point. It is also preferred for salad dressings owing to its ability to maintain viscosity and consistency at low temperatures. It is also preferred for hydrogenation over soybean and canola oils.[24,25] It primarily comprises linoleic acid, which is seen in the highest quantity in safflower oil. Linoleic acid is retained as a chief ingredient even in the blended form of safflower oil with rice bran oil. The rest of the oil comprises oleic and palmitic acids.[13]

Palmitic and oleic acids make up the major proportions in *HVO* and *butter oil.* However, the levels of palmitic and oleic acids in the non-branded butter oil are higher than those in the branded version, which may be because of adulteration with cheaper HVO. The average of total SFA found in branded butter has been reported to be higher than that recommended by the United States Department of Agriculture (USDA) 2007, whereas this was reported to be within limits for non-branded butter. On the other hand, MUFA and PUFA levels in branded butter were found to be within the prescribed limit by the USDA, whereas they exceeded in the case of non-branded butter. The levels of the lower fatty acids, namely, butyric and caproic acids, were found to be 2.2 and 4.5 times, respectively, higher than those recommended by the USDA for branded butter. The average TFA levels for butter oil and butter for both branded and non-branded types exceeded the limits prescribed by Denmark.[15]

Clarified butter, also known as *ghee,* has been consumed by Indians since ages. The preparation of ghee involves the heating of cow- or buffalo-milk butter at >100°C followed by its filtration. Industrially, it is processed in dairies by direct cream method. Palmitic acid is the predominant fatty acid in ghee, second to which is oleic acid. It also contains stearic and myristic acids. Additionally, it has low quantities of lauric, linoleic, capric and palmitoleic acids with trace amounts of butyric, caproic, caprylic, arachidic, myristoleic and linolenic acids and even TFA.

Partially hydrogenated vegetable oil (PVHO), known as vanaspati or vegetable ghee, is a cheap alternative to ghee. Its physical properties are similar to that of ghee, and it forms 10% of the total edible oil production. It is prepared by partial hydrogenation of various edible oils at a definite temperature and pressure in the presence of nickel, which acts as a catalyst. To manufacture vanaspati, 20 types of oils have been recommended by the 'Vegetable Oil Products (Regulation) Order', 1998. Like in ghee, palmitic acid is reportedly present in the highest amount in vanaspati, followed by oleic acid. The TFA elaidic acid in vanaspati, however, has been found to be in the range of 1.04%–12.09%, which exceeds the maximum limit suggested by FSSAI for PVHOs.[13]

Intake of edible oils and fats in Indian population

Calculations based on the National Sample Survey Organization (NSSO), Government of India, reveal that the mean intake of TFA among the Indian population is 0.09 g/day–0.33 g/day, following the consumption of edible oils and fats.[15] As per the WHO, TFA intake should not exceed 1% of the total daily energy intake. Considering 2400 calories to be the daily calorie intake for the Indian population, Dixit et al showed that the daily TFA intake for the Indian population should be lower than the WHO recommended limits.[15] However, the TFA intake in the Northern states has been observed to be higher, with that of Punjab being 1.09 times more than the value recommended by WHO.[15] There are recent advances by FSSAI in reducing the TFA limits from the current allowed 5% to 2% by 2022.

Assoiation of edible oils and fats with health outcomes

We reviewed a total of 34 articles that assessed the impact of oils and fats on anthopometric parameters such as weight, BMI, waist circumference and neck circumference; lipid profile, which included total cholesterol, LDL and HDL levels and LDL/HDL ratio; CVD risk factors assessed by cardiac events, blood pressure and myocardial infarction and risk of developing diabetes assessed by fasting blood glucose and HbA1c readings. Thereafter, the positive and negative effects on these parameters were evaluated against each oil used as an intervention.

Anthropometric parameters

Randomized controlled trials have been conducted in this area to assess the effect of olive, sesame and coconut oils on anthropometric parameters in humans, which have reported inconsistent results. However, studies point towards a slight positive effect of coconut oil on body measures. In a randomized controlled trial comparing the effect of *virgin coconut oil (VCO)* and *safflower oil (SO)* on postmenopausal women, Harris et al reported no difference between the two groups when it came to parameters like body weight, waist circumference and hip circumference.[26] Although not statistically significant, a small increase in lean mass was observed in the VCO-consumption group.[26] Similar positive effect has also been reported by Assunçao et al, who also observed a reduction in abdominal obesity in women consuming 30 mL of coconut oil daily.[27] A significant decrease in BMI, neck circumference and waist circumference have also been reported in the case of patients with coronary artery disease (CAD) who consumed extra-virgin coconut oil for 3 months (13 mL/day).[28] There is a growing interest of research in olive oil, although it has not shown any positive effects on anthropometric parameters.

Studies in this area are scarce in Indian context. Vijaykumar et al reported no difference in the effect of coconut oil versus *sunflower oil* in patients with CAD in Kerela.[29] However, a positive effect of using sesame oil for 45 days has been observed in terms of causing a significant decrease in body weight and BMI in adults with hypertension.[30] Only one study was retrieved that recorded the effect of feeding coconut oil added to breast milk against feeding only breast milk on weight gain, length, head circumference and skin folds in very low birth weight infants. The weight gain, length and head circumference noted across both groups did not show a statistically significant difference, whereas there was a significantly higher subscapular skinfold thickness in the infants who were fed with coconut oil added to breast milk.

Lipid profile

Effect of oils and fats on the lipid profile has been researched more than any other health outcome that has been mentioned in this paper. We reviewed 23 studies reporting the effect of various oils and fats, such as coconut, sesame, sunflower, soybean, olive (low phenolic and high phenolic), palm, mustard and groundnut oils and vanaspati and ghee, including animal studies and review papers. Of them, 10 were conducted in India.

Sudhakar et al reported a decrease in all the parameters of lipid profile, except HDL-C, after 45 days in patients with hypertension who received nifedipine along with a combination of sesame and sunflower oils.[31] Positive effect of *sunflower oil* on lipid profile, which is observed as a significant decrease in serum triacylglycerol and VLDL levels, has also been reported.[32] The findings of Vijaylaxmi et al, however, were in disagreement; they indicated that lipid parameters such as TC, LDL-C, VLDL-C and triglyceride levels and risk ratios (TC/HDL-C, LDL-C/HDL-C), except HDL-C, were higher in individuals falling under high-income group using *sunflower and safflower oils* in Karnataka.[33]

A study conducted in Brazil reported an increase in HDL levels and a decrease in LDL/HDL ratio after 1-week supplementation of a daily dose of 30 mL of coconut oil, whereas the opposite effect was observed with soybean oil on the lipid profile.[27] Other studies have also recorded similar results.[32,34–36] Furthermore, the findings of Kochikuzhyil et al demonstrated a similar effect of *coconut oil* on rats induced with type 2 diabetes mellitus.[37] On the contrary, no significant effect of coconut and sesame oils was observed on the lipid profile by Vijaykumar et al and Sankar et al, respectively.[29,30] Similar findings have been reported by Sabitha et al and Arun et al.[34,38] Moreover, the study by Dineshkumar et al, which compared the effects of coconut oil with other types of oils commonly used in India on the lipid profile of individuals with type 2 diabetes mellitus, demonstrated that coconut oil does not play a significant role in increasing HDL levels. Conversely, they reported that soybean oil caused a significant decrease in total cholesterol and LDL levels and a significant increase in HDL levels.[39]

Olive oil was not shown to have any effect on lipid profile when tested for both its low phenolic and high phenolic forms, although an increase in HDL levels has been observed after a supplementation period of 6 weeks in healthy adults aged 18–75 years.[40] On the contrary, a negative effect in the form of increased LDL levels has been reported in a study by Prasad RM et al on Wistar rats in 2016.[32]

Ghee and *mustard oil* are commonly used in a typical Indian diet. There is only one study comparing the usage of ghee to that of mustard oil. A recent study by Sharma et al has reported that the use of >1.25 kg/month of ghee along with <0.5 L/month of mustard oil is associated with significantly lower TG, TC, VLDL, TC/HDL and LDL/HDL levels and higher HDL levels.[41] An adverse effect was reported on lipid profiles in individuals who used less of ghee and more of mustard oil in their diet.[41] Prasad et al reported that vanaspati caused a significant increase in LDL levels in Wistar rats.[32]

Risk to cardiovascular health

The effect of oils and fats on cardiovascular health may be direct or indirect. The direct effects have been linked to lipid profiles and lipid peroxidation, which are, in turn, associated with the progression of atherosclerosis. The indirect effects can be via the promotion of weight gain, which further increase the CVD risk. Studies that have evaluated the effects of consumption of oils and fats on cardiovascular health have assessed various parameters, such as the incidence and prevalence of CVD-related events, lipid profiles, anthropometric parameters and anti-inflammatory and anti-oxidant effects.

In our literature search of the 15 research articles, 4 indicated positive effect of *coconut oil* on cardiovascular health in terms of improved lipid profile, anthropometric parameters and CVD clinical events.[26,28,42,43] Majority of the studies involved the usage of either virgin or *extra-virgin coconut oil.* The high phenolic content of extra-virgin oil normalizes lipids via various pathways. In combination to this, its anti-inflammatory and antioxidant effects have been shown to play a role in preventing atherosclerosis.[42] Cardoso et al found that diastolic blood pressure decreased in patients with CAD after 3 months of supplementation with extra-virgin coconut oil; however, there was no effect observed when this was adjusted for BMI.[28] On the other hand, Eyres et al suggested the use of cis-unsaturated fatty acid-rich vegetable oils instead of coconut oil because the latter increased total cholesterol and LDL levels.[44]

Studies in Indian setting have also highlighted the positive effect that *sesame* and *sunflower oils* may have on cardiovascular health. Devarajan et al reported reduction in blood pressure in patients with essential hypertension. This effect was even better in patients who consumed sesame oil for 60 days in combination with nifedipine.[45] The findings of Sudhakar et al were consistent with these results.[31] Carmen's review on the effect of vegetable oils demonstrated the beneficial effect of virgin olive oil on CVD clinical events as an evidence from randomized controlled trials, which included the consumption of virgin olive oil in high amounts.[43] The findings of studies on mustard oil have been inconsistent; however, majority of such studies conducted earlier have suggested an inverse relationship, with reduced cases of ischemic heart disease and acute myocardial infarction.[41,46–48]

Other types of oils, such as palm oil and oils with trans fats, have been known to have a negative effect on cardiovascular health. The odds of coronary heart disease (CHD), according to one study, increase by 50.9% among individuals who consume >1 L of mustard oil every month.[48] In addition, for every 1% increase in TFA intake, HDL levels decrease by 1% and LDL levels increase by 1%. Furthermore, a 2–3 g increase in the intake of SFA lowers the risk for CHD by 21%.[49] The association of palm oil with increased risk for myocardial infarction has been reported in multiple review articles. It has been estimated that a 20% increase in tax on palm oil can help avert approximately 3,63,000 deaths from myocardial infarction.[50–52]

Risk of developing diabetes

Although, there is a relative dearth of scientific literature in this area, several articles have indicated the possible role of olive oil in decreasing the risk of developing type 2 diabetes mellitus.[43,53,54] This effect can be attributed to the anti-inflammatory properties of *virgin olive oil.* In addition, olive oil is known to reduce glycemic load of a meal, which leads to an increase in the carbohydrate absorption rate and insulin secretion. However, a study by Silva et al has demonstrated contradictory results, where both low- and high-phenolic forms of olive oil caused an increase in fasting blood glucose levels.[40] In Indian context, the findings of Bhardwaj et al indicated a protective effect of omega-6 fatty acids and *flax seed oil* on the risk of developing diabetes.[55] On the other hand, TFA, which can be deleterious to cardiovascular health, is known to worsen insulin resistance.[49]

Conclusion

Edible oils are and will continue to be a chief medium of cooking in Indian kitchens. With the emerging middle class and shifting demand towards packaged-food options, it is important that the impact of edible oils on health is understood well. Here we attempted to condense available body of evidence around this issue. Although comprehensive, this review is not exhaustive. Our objective was to provide an evidence-based update on the impact of edible oils on select health outcomes. The era of globalized technology-aided shopping options, with online deliveries and preference to buy from supermarkets, is liberating consumers and allowing them to indulge. If consumers are well-informed about the choices they have, particularly pertaining to the impact of everyday-used food items, such as edible oils, on health, it will help in empowering them. The bigger picture, including demand and supply of oils, may also influence policy subsidies, taxation, etc. surrounding edible oils.

Edible oils are only one important component of our diet. As public health nutrition professionals, it is also important to emphasise on choosing a healthier diet and leading an active lifestyle. Just picking one or two food items and not syncing it with an overall healthy lifestyle may still lead to the development of and further rise in the prevalence of risk factors for NCDs among masses.

Box 1

Fatty acids differ from one another in two ways: the length of chain and degree of saturation. With respect to the degree of saturation, fatty acids can be classified into saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. SFA, or saturated fats, consist of fatty acids whose carbon chain is 'saturated' with hydrogen. These fats are primarily found in foods of animal origin—such as meat, poultry, dairy products and eggs—and in coconut, palm and palm kernel oils. High intake of SFA is associated with increased risk of coronary artery disease. MUFA lack one pair of hydrogen atoms in their carbon chain. Canola, nut and olive oils are rich in MUFA and are liquid at room temperature. A diet with MUFA as the primary source of fat (frequently in the form of olive oil) and only small amounts of animal products has been linked to a lower risk of coronary artery disease. PUFA lack two or more pairs of hydrogen atoms in their carbon chain. Safflower, sunflower, sesame, corn and soybean oils are rich in PUFA and are also liquid at room temperature. Trans fatty acids (TFA), another type of fatty acid, are either naturally occurring or industrially produced in commercial quantities by a process known as hydrogenation. Hydrogenation involves the treatment of oils and fats with hydrogen gas in the presence of a catalyst resulting in the selective addition of hydrogen to the carbon-to-carbon double bonds.

References

1. Geldsetzer P, Manne-Goehler J, Theilmann M, Davies JI, Awasthi A, Danaei G, et al. Geographic and sociodemographic variation of cardiovascular disease risk in India: A cross-sectional study of 797,540 adults. PLoS Med. 2018;15(6):e1002581.

2. Neuhouser ML. The importance of healthy dietary patterns in chronic disease prevention. Nutr Res. 2018. doi:10.1016/j.nutres.2018.06.002

3. Yu E, Malik VS, Hu FB. Cardiovascular Disease Prevention by Diet Modification. J Am Coll Cardiol. 2018;72:914–26.

4. Yakoob MY, Micha R, Khatibzadeh S, Singh GM, Shi P, Ahsan H, et al. Impact of dietary and metabolic risk factors on cardiovascular and diabetes mortality in South Asia: analysis from the 2010 Global Burden of Disease Study. Am J Public Health. 2016;106(12):2113–25.

5. Jha GK, Pal S, Mathur VC, Bisaria G, Anbukkani P, Burman RR, et al. Edible oilseeds supply and demand scenario in India: Implications for policy. Report of the Indian Agricultural Research Institute. 2012.

6. O'brien RD. Fats and oils: formulating and processing for applications. (CRC Press, 2008).

7. Aro A, Salminen I, Huttunen JK, Kardinaal AF, van't Veer P, Kark JD, et al. Adipose tissue isomeric trans fatty acids and risk of myocardial infarction in nine countries: the EURAMIC study. Lancet. 1995;345(8945):273–8.

8. Pingali PL, Khwaja Y. Globalisation of Indian diets and the transformation of food supply systems. 2004.

9. Jha GK, Pal S, Mathur VC, Bisaria G, Anbukkani P, Burman RR, Dubey SK. Edible oilseeds supply and demand scenario in India: Implications for policy. Report of the Indian Agricultural Research Institute. 2012.

10. Mani I, Kurpad AV. Fats & fatty acids in Indian diets: Time for serious introspection. Indian J Med Res. 2016;144(4):507.

11. Fattore E, Massa E. Dietary fats and cardiovascular health: a summary of the scientific evidence and current debate. Int J Food Sci Nutr.2018;69:916–27.

12. Adolescent health. WHO [Internet] 2018 [cited 2019 Jan 02]. Available from:
https://www.who.int/maternal_child_adolescent/adolescence/en.

13. Dorni C, Sharma P, Saikia G, Longvah T. Fatty acid profile of edible oils and fats consumed in India. Food Chem. 2018;238:9–15.

14. Srinivasan PV. Impact of trade liberalization on India's oilseed and edible oils sector. 2012.

15. Dixit S, Das M. Fatty acid composition including trans-fatty acids in edible oils and fats: probable intake in Indian population. J Food Sci. 2012;77.

16. Mani I, Kurpad AV. Fats & fatty acids in Indian diets: Time for serious introspection. Indian J Med Res. 2016;144:507–14.

17. Zaeroomali M, Maghsoudlou Y, Aryaey P, Nateghi L. Investigation of physicochemical, microbial and fatty acids profile of table margarine made with palm and soybean oils. Euro J Exp Bio. 2014;4(3):185–7.

18. Arora NK, Nair MK, Gulati S, Deshmukh V, Mohapatra A, Mishra D, et al. Neurodevelopmental disorders in children aged 2–9 years: Population-based burden estimates across five regions in India. PLoS Med. 2018;15(7):e1002615. doi:10.1371/journal.pmed.1002615

19. Agarwal DK, Singh P, Chakrabarty M, Shaikh AJ, Gayal SG. Cottonseed oil quality, utilization and processing. 2003.

20. Suja KP, Abraham JT, Thamizh SN, Jayalekshmy A, Arumughan C. Antioxidant efficacy of sesame cake extract in vegetable oil protection. Food Chem. 2004;84:393–400.

21. Schleifer P. Private governance undermined: India and the roundtable on sustainable palm oil. Global environmental politics. 2016;16(1):38–58.

22. World Health Organization. Interim Summary of Conclusions and Dietary Recommendations on Total Fat & Fatty Acids. From the Joint FAO/WHO Expert Consultation on Fats and Fatty Acids in Human Nutrition, November 10-14, 2008, WHO HQ, Geneva. 2008.

23. Liu L, Guan L, Wu W, Wang L. A Review of Fatty Acids and Genetic Characterization of Safflower (Carthamus tinctorius L.) Seed Oil. Org Chem Curr Res. 2016;5:1–4.

24. Frankel EN, Huang SW. Improving the oxidative stability of polyunsaturated vegetable oils by blending with high-oleic sunflower oil. J Am Oil Chem Soc. 1994;71:255–9.

25. Ekin Z. Resurgence of Safflower (Carthamus tinctorius L.) Utilization: A Global View. J Agron. 2005;4:83–7.

26. Harris M, Hutchins A, Fryda L. The Impact of Virgin Coconut Oil and High-Oleic Safflower Oil on Body Composition, Lipids, and Inflammatory Markers in Postmenopausal Women. J Med Food. 2017;20:345–51.

27. Assunçao ML, Ferreira HS, dos Santos AF, Cabral Jr CR, Florêncio TM. Effects of dietary coconut oil on the biochemical and anthropometric profiles of women presenting abdominal obesity. Lipids. 2009;44:593–601.

28. Cardoso DA, Moreira AS, de Oliveira GM, Raggio Luiz R, Rosa G. A coconut extra virgin oil-rich diet increases HDL cholesterol and decreases waist circumference and body mass in coronary artery disease patients. Nutr Hosp. 2015;32:2144–52.

29. Vijayakumar M, Vasudevan DM, Sundaram KR, Krishnan S, Vaidyanathan K, Nandakumar S, et al. A randomized study of coconut oil versus sunflower oil on cardiovascular risk factors in patients with stable coronary heart disease. Indian Heart J. 2016;68:498–506.

30. Sankar D, Rao MR, Sambandam G, Pugalendi KV. Effect of sesame oil on diuretics or ß-blockers in the modulation of blood pressure, anthropometry, lipid profile, and redox status. Yale J Biol Med. 2006;79:19–26.

31. Sudhakar B, Kalaiarasi P, Al-Numair KS, Chandramohan G, Rao RK, Pugalendi KV. Effect of combination of edible oils on blood pressure, lipid profile, lipid peroxidative markers, antioxidant status, and electrolytes in patients with hypertension on nifedipine treatment. Saudi Med J. 2011;32:379–85.

32. Prasad RM, D'Souza U, Bhat S, Bhat KM. Effect of vegetable oils on the lipid profile and antioxidant status in Wistar rats : A comparative study. J Int Med Dent. 2016;3:109–14.

33. Vijayalaxmi MP, Kasturiba B, Naik RK, Malagi U. Influence of Fats and Oils Intake on the Lipid Profile of Adults Belonging to Different Income Groups. Karnataka J Agric Sci. 2015;20:112–14.

34. Sabitha P, Vaidyanathan K, Vasudevan DM, Kamath P. Comparison of lipid profile and antioxidant enzymes among south Indian men consuming coconut oil and sunflower oil. Indian J Clin Biochem. 2009;24:76–81.

35. Sreeji KP. Effect of coconut oil on lipid profile and antioxident status in rats (Doctoral dissertation, College of Veterinary and Animal Sciences, Mannuthy). 2010.

36. Manjeshwar PR, D'Souza U, Bhat S, Bhat KM, Arunkumar N. Effect of various vegetable oils on the lipid profile and antioxidant status in hypercholesterolaemic Wistar rats - A Comparative Study. J Evid Based Med Heal. 2017;4:778–82.

37. Kochikuzhyil BM, Devi K, Fattepur SR. Effect of saturated fatty acid-rich dietary vegetable oils on lipid profile, antioxidant enzymes and glucose tolerance in diabetic rats. Indian J Pharmacol. 2010;42:142.

38. Arun S, Kumar M, Paul T, Thomas N, Mathai S, Rebekah G, et al. An Open-label Randomized Controlled Trial to Compare Weight Gain of Very Low Birth Weight Babies with or without Addition of Coconut Oil to Breast Milk. J Trop Pediatr. 2018;1–8. doi:10.1093/tropej/fmy012

39. Dineshkumar B, Mukherjee S, Pradhan R, Mitra A, Chakraborty C. Effects of edible oils in type 2 diabetes mellitus. J Clin Diagnostic Res. 2009;3:1389–94.

40. Silva S, Bronze MR, Figueira ME, Siwy J, Mischak H, Combet E, et al. Impact of a six-week olive oil supplementation in healthy adults on urinary proteomic biomarkers of coronary artery disease, chronic kidney disease and diabetes. Atherosclerosis. 2015;241:e41.

41. Sharma HB, Vyas S, Kumar J, Manna S. Beneficial effect of ghee consumption over mustard oil on lipid profile: A study in North Indian adult population. J Complement Integr Med. 2018;15:1–7.

42. Babu AS, Veluswamy SK, Arena R, Guazzi M, Lavie CJ. Virgin coconut oil and its potential cardioprotective effects. Postgrad Med. 2014;126:76–83.

43. Sayon-Orea C, Carlos S, Martínez-Gonzalez MA. Does cooking with vegetable oils increase the risk of chronic diseases?: A systematic review. Br J Nutr. 2015;113:S36–48.

44. Eyres L, Eyres MF, Chisholm A, Brown RC. Coconut oil consumption and cardiovascular risk factors in humans. Nutr Rev. 2016;74:267–80.

45. Devarajan S, Singh R, Chatterjee B, Zhang B, Ali A. A blend of sesame oil and rice bran oil lowers blood pressure and improves the lipid profile in mild-to-moderate hypertensive patients. J Clin Lipidol. 2016;10:339–49.

46. Rastogi T, Reddy KS, Vaz M, Spiegelman D, Prabhakaran D, Willett WC, et al. Diet and risk of ischemic heart disease in India. Am J Clin Nutr. 2004;79:582–92.

47. Singh RB, Niaz MA, Sharma JP, Kumar R, Rastogi V, Moshiri M. Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: The Indian experiment of infarct survival—4. Cardiovasc Drugs Ther. 1997;11:485–91.

48. Manna S, Sharma HB, Vyas S, Kumar J. Comparison of mustard oil and ghee consumption on the history of coronary heart disease in urban population of India. J Clin Diagnostic Res. 2016;10:OC01-5.

49. Khosla I, Khosla GC. Saturated fats and cardiovascular disease risk: A review. J Clin Prev Cardiol. 2017;6:56.

50. Prabhakaran D, Jeemon P, Roy A. Cardiovascular Diseases in India: Current Epidemiology and Future Directions. Circulation. 2016;133:1605–20.

51. Ismail SR, Maarof SK, Ali SS, Ali A. Systematic review of palm oil consumption and the risk of cardiovascular disease. PLoS One. 2018;13:e019353.

52. Pearson-Stuttard J, Bandosz P, Rehm CD, Penalvo J, Whitsel L, Gaziano T, et al. Reducing US cardiovascular disease burden and disparities through national and targeted dietary policies: A modelling study. PLOS Med. 2017;14:e1002311.

53. Schwingshackl L, Lampousi AM, Portillo MP, Romaguera D, Hoffmann G, Boeing H. Olive oil in the prevention and management of type 2 diabetes mellitus: A systematic review and meta-analysis of cohort studies and intervention trials. Nutr Diabetes. 2017;7:e262–6.

54. Guasch-Ferré M, Hruby A, Salas-Salvadó J, Martínez-González MA, Sun Q, Willett WC, et al. Olive oil consumption and risk of type 2 diabetes in US women. Am J Clin Nutr. 2015;102:479–86.

55. Bhardwaj K, Verma N, Trivedi RK, Bhardwaj S. Flaxseed oil and diabetes: A systemic review. J Med Sci. 2015;15:135–8.

56. Ghafoorunissa. Dietary lipids and heart disease – the Indian context. Natl Med J India. 1994;7(6):270–6.

57. Johnson S, Saikia N. Fatty acids profile of Edible Oils and Fats in India. Pollution Monitoring Laboratory, Centre for Science and Environment. 2009;1–33.

58. Manchanda SC, Passi SJ. Selecting healthy edible oil in the Indian context. Indian Heart Journal. 2016;68(4):447–9.

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